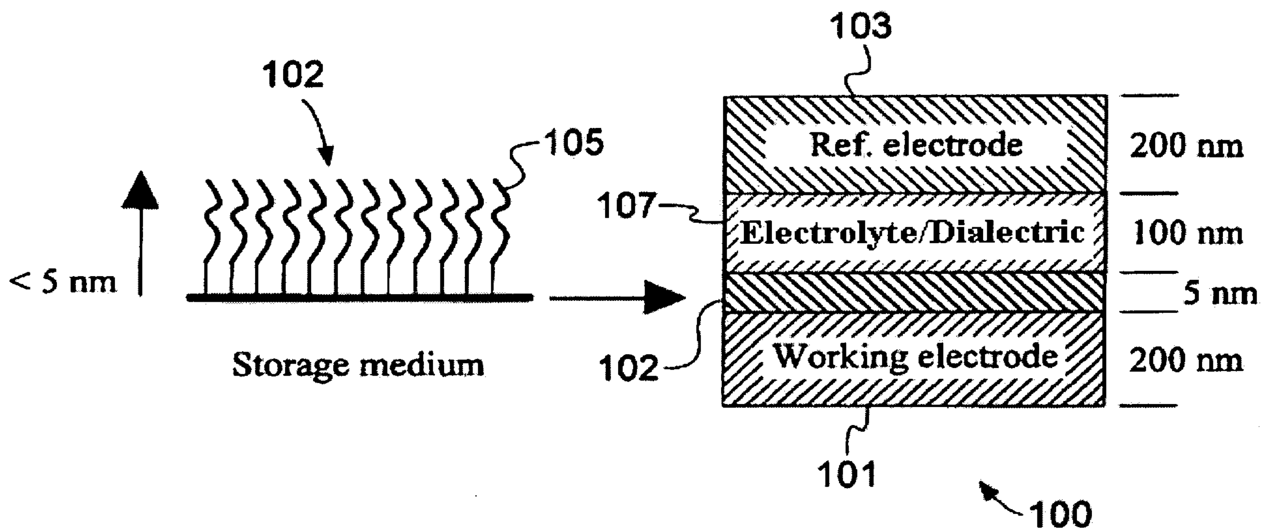
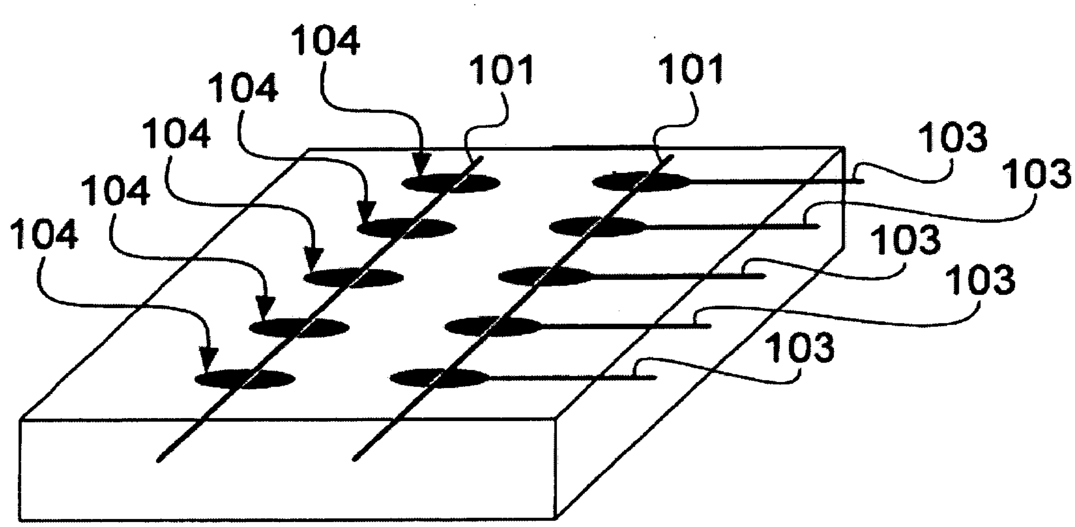


103
102
105
107
< 5 nm
Ref. electrode
200 nm
Electrolyte/Dialectric
100 nm
5 nm
Storage medium
102
Working electrode
200 nm
101
100

Fig. 1



104
104
104
104
104
101
101
103
103
103
103
103

Fig. 2

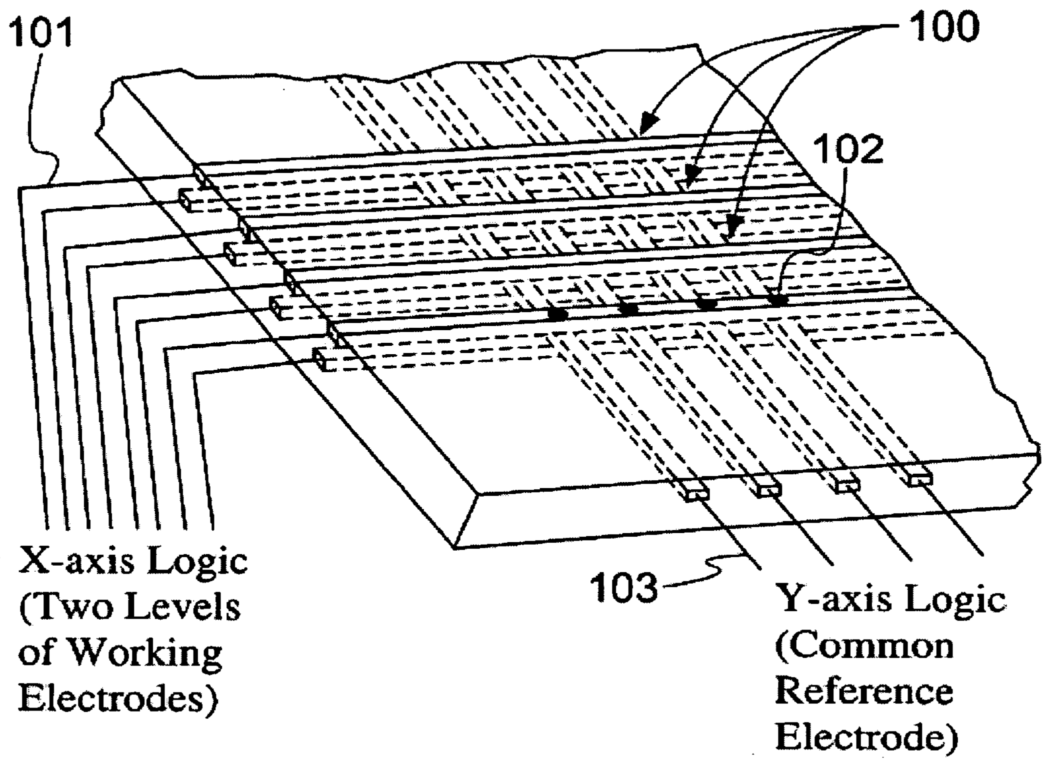

101
100
102
X-axis Logic
(Two Levels
of Working
Electrodes)
103
Y-axis Logic
(Common
Reference
Electrode)

Fig. 3

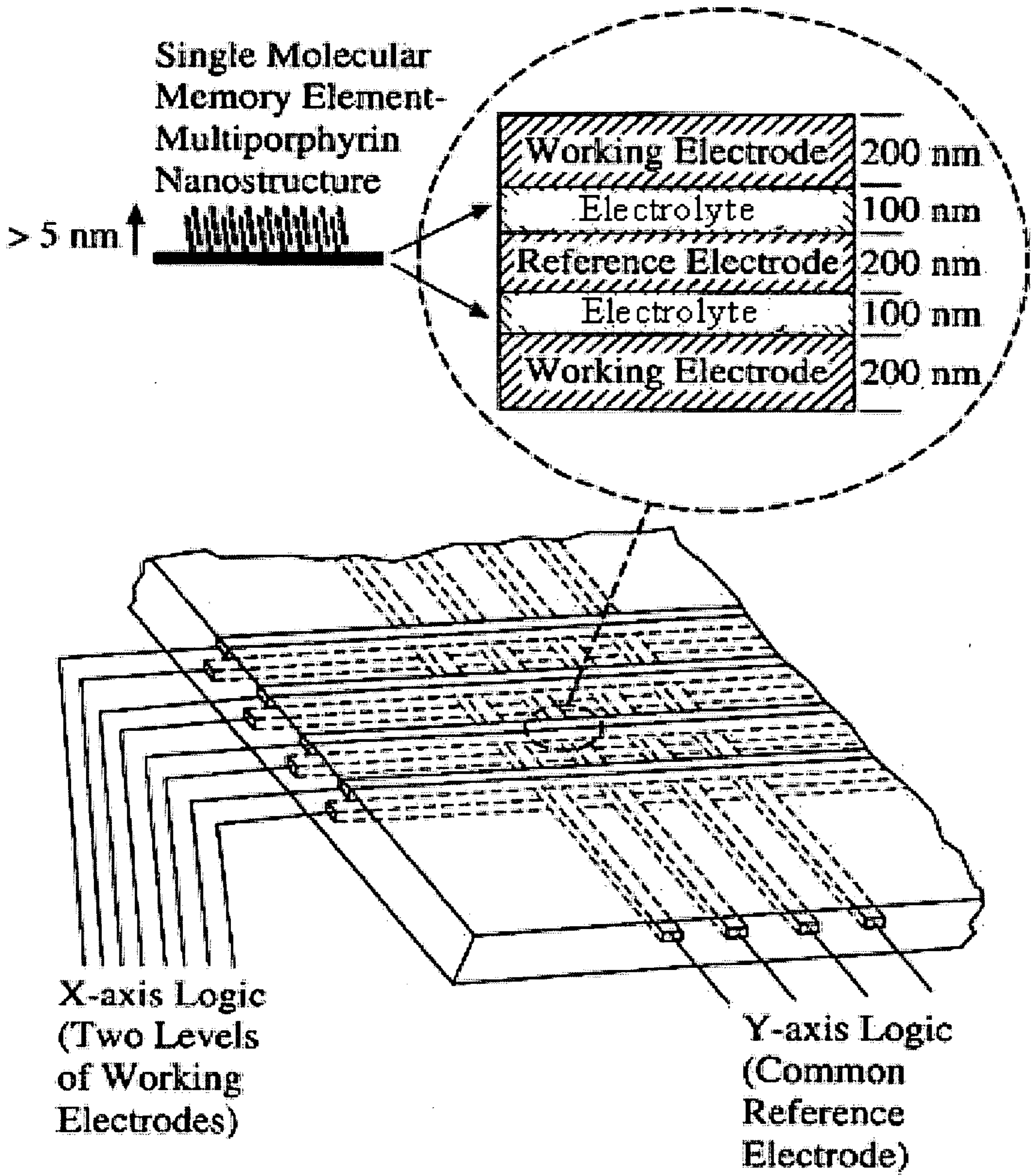
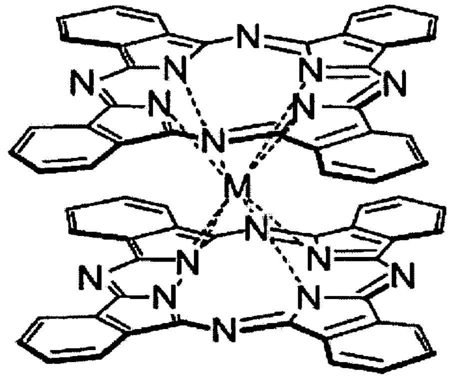
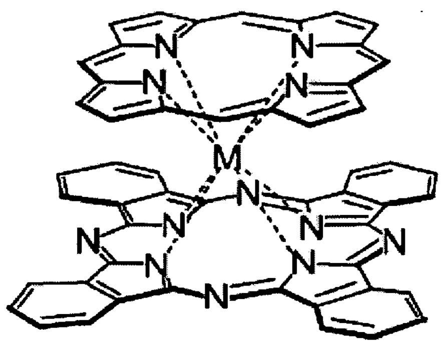

Single Molecular
Memory Element-
Multiporphyrin
Nanostructure
> 5 nm
Working Electrode
200 nm
Electrolyte
100 nm
Reference Electrode
200 nm
Electrolyte
100 nm
Working Electrode
200 nm
X-axis Logic
(Two Levels
of Working
Electrodes)
Y-axis Logic
(Common
Reference
Electrode)

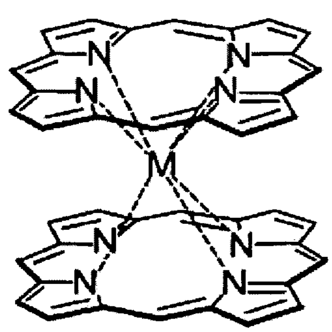
Fig. 4



(Pc)M(Pc)



(Por)M(Pc)



(Por)M(Por)

Fig. 5

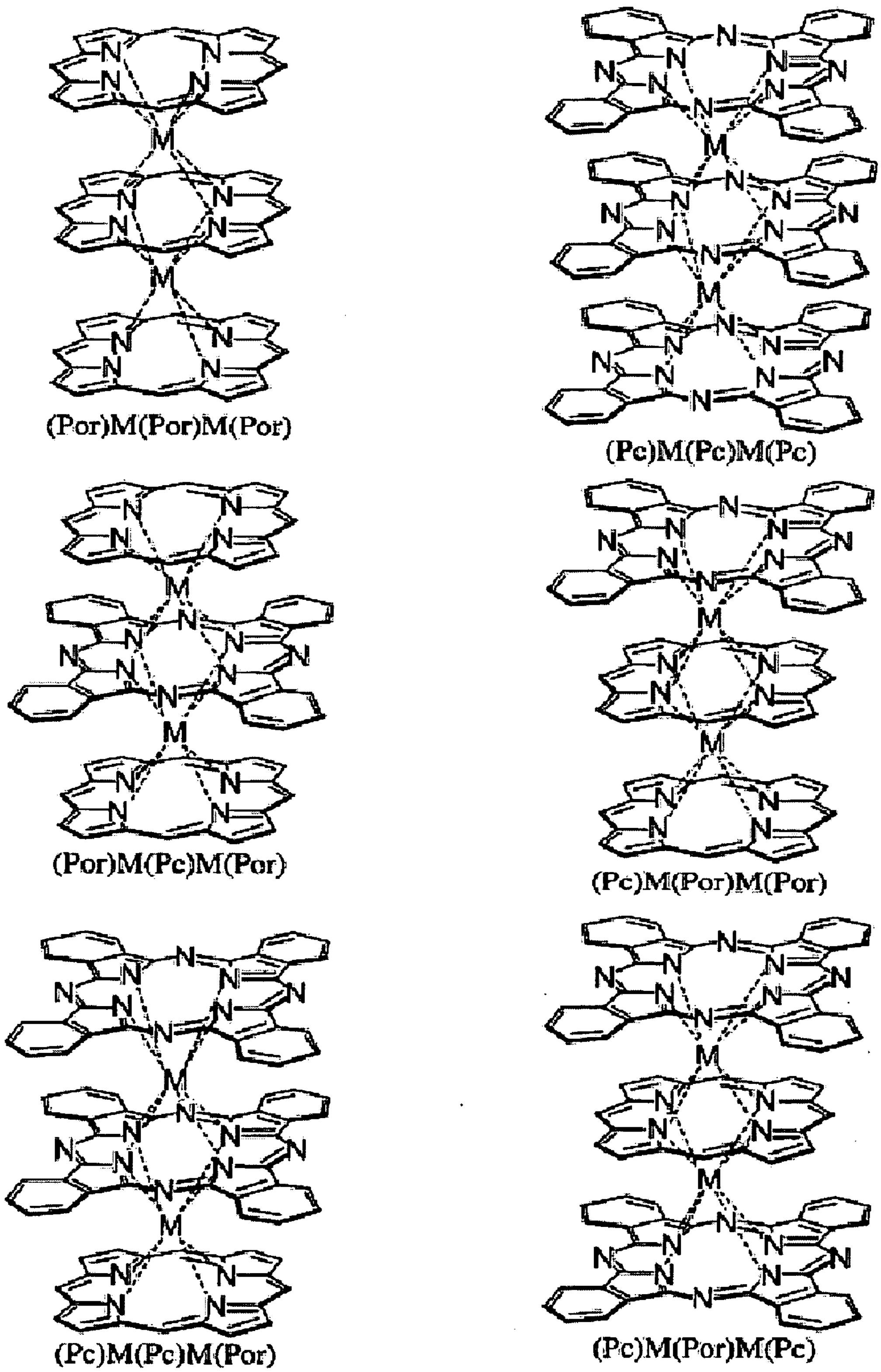

(Por)M(Por)M(Por)
(Pc)M(Pc)M(Pc)
(Por)M(Pc)M(Por)
(Pc)M(Por)M(Por)
(Pc)M(Pc)M(Por)
(Pc)M(Por)M(Pc)

Fig. 6

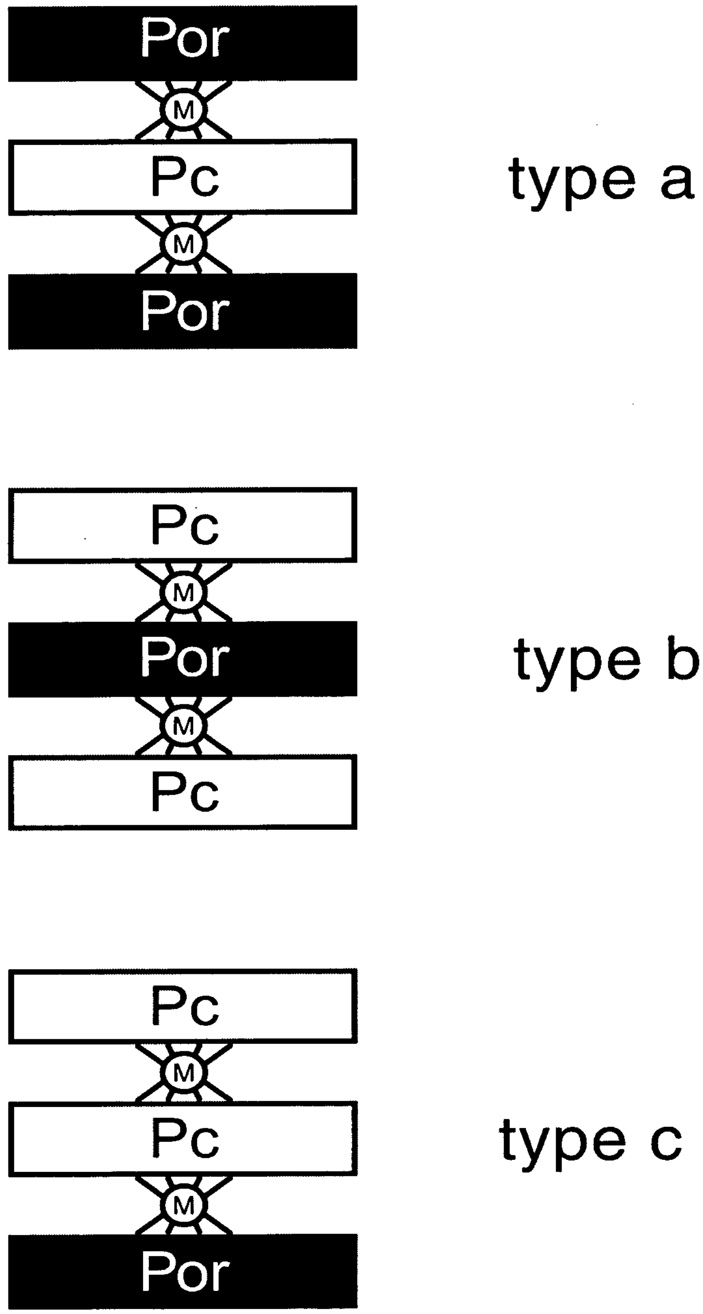


Fig. 7

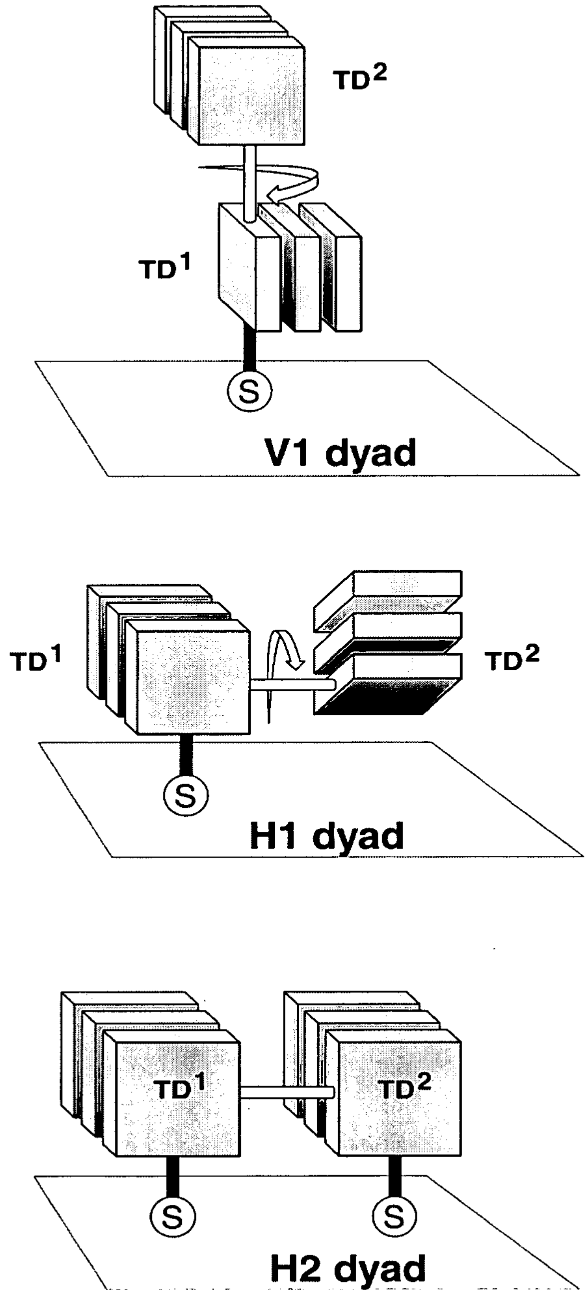


Fig. 8

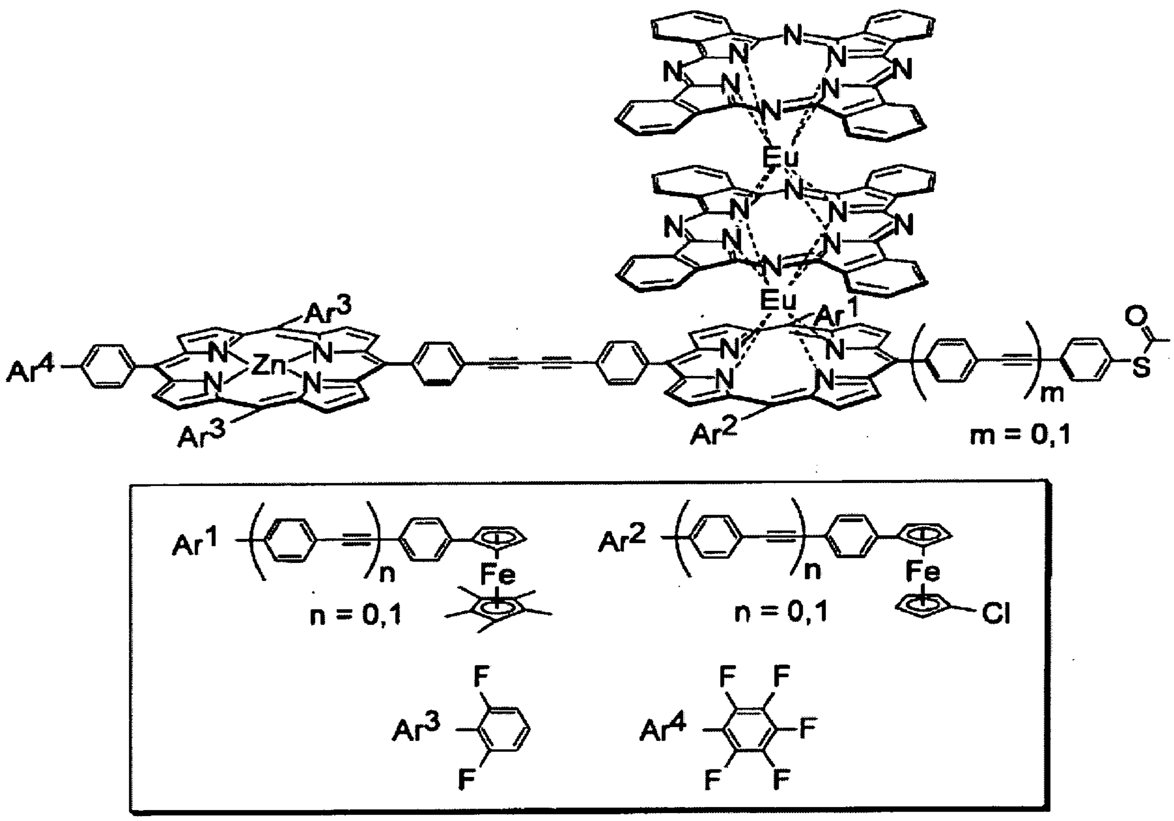


Fig. 9

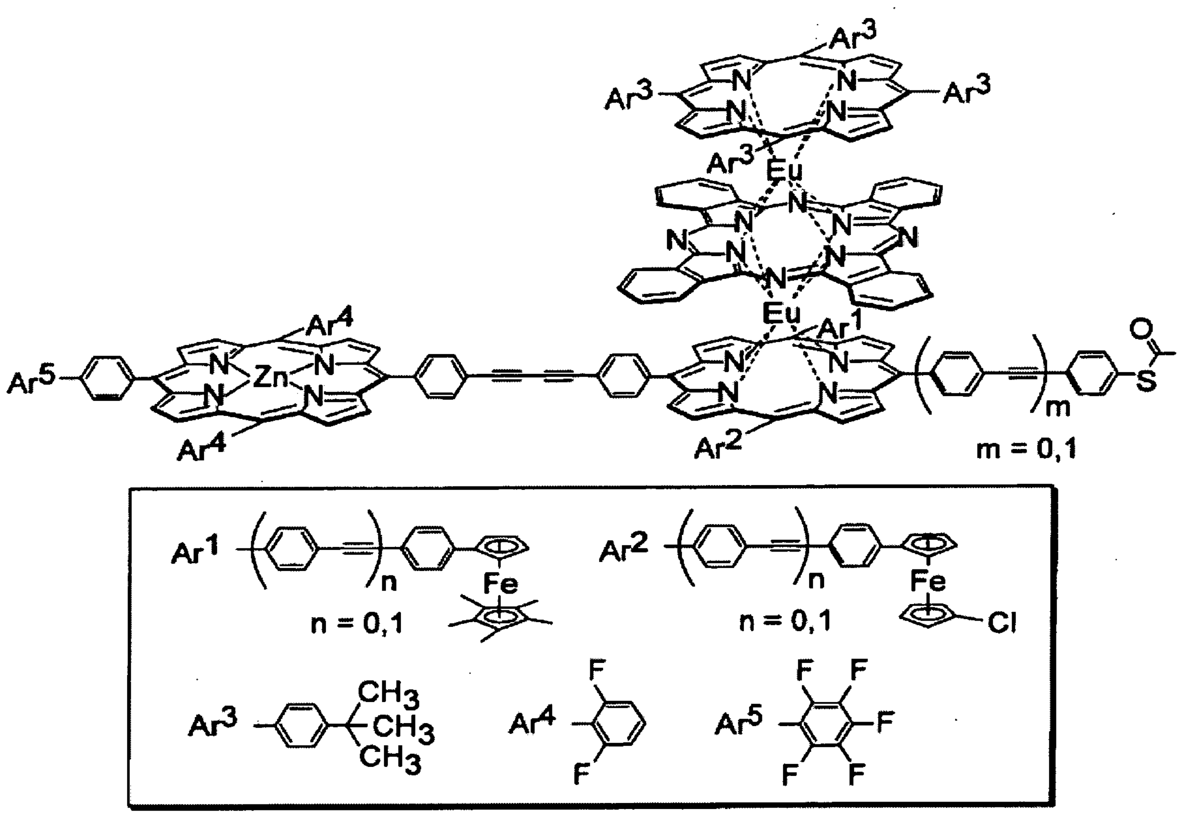


Fig. 10

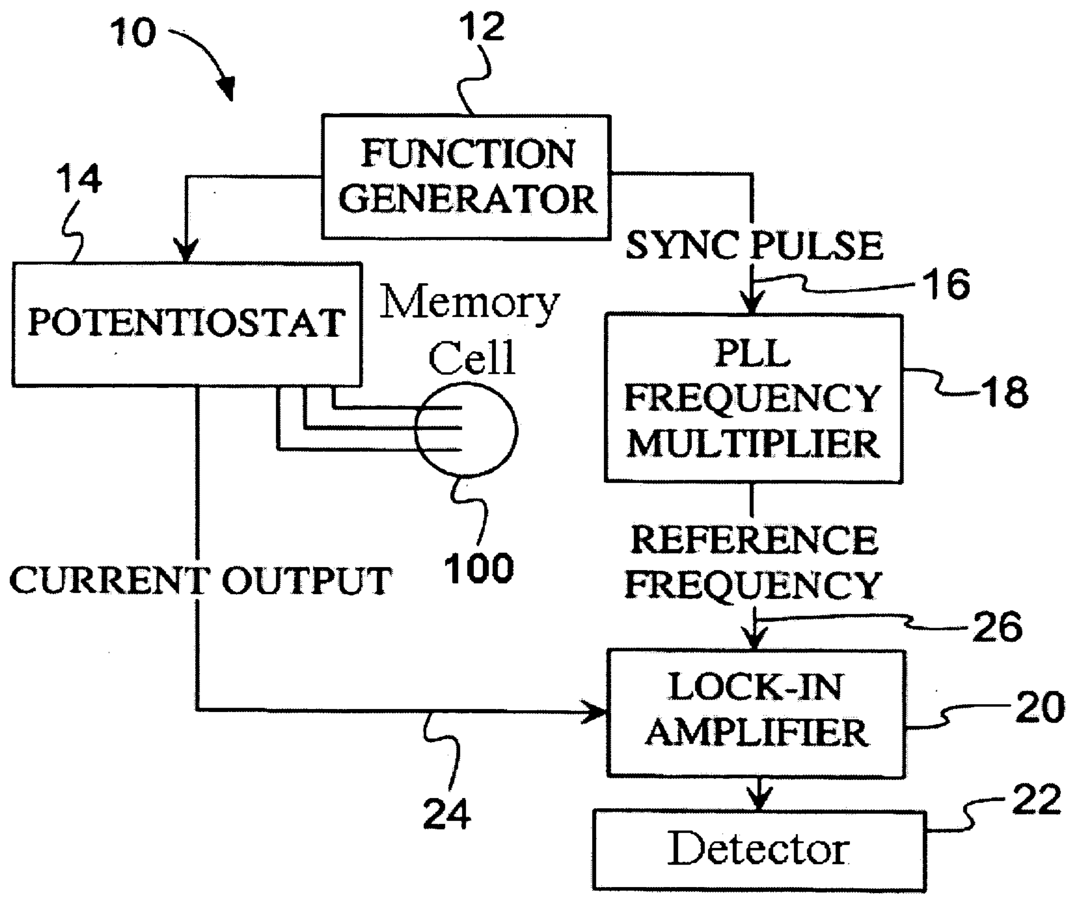
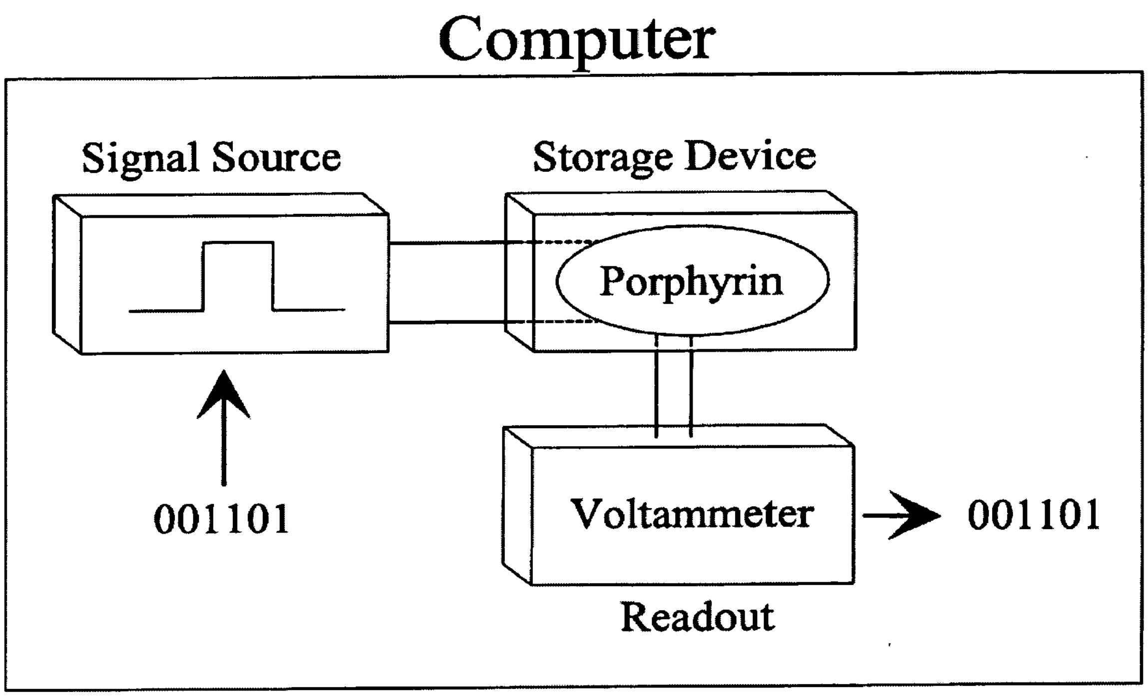

10
12
FUNCTION GENERATOR
14
POTENTIOSTAT
Memory Cell
SYNC PULSE
16
PLL FREQUENCY MULTIPLIER
18
100
CURRENT OUTPUT
REFERENCE FREQUENCY
26
LOCK-IN AMPLIFIER
20
24
Detector
22

Fig. 11



Computer
Signal Source
Storage Device
Porphyrin
001101
Voltammeter
001101
Readout

Fig. 12

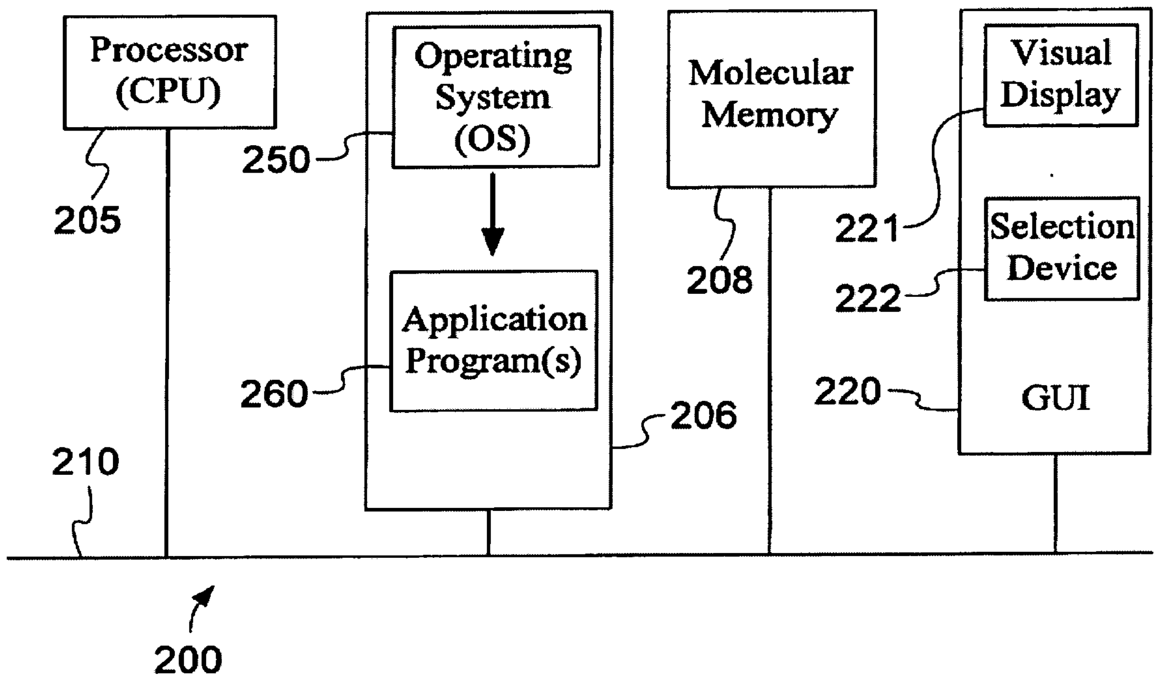

Processor (CPU)
205
Operating System (OS)
250
Application Program(s)
260
206
Molecular Memory
208
Visual Display
221
Selection Device
222
220
GUI
210
200

Fig. 13

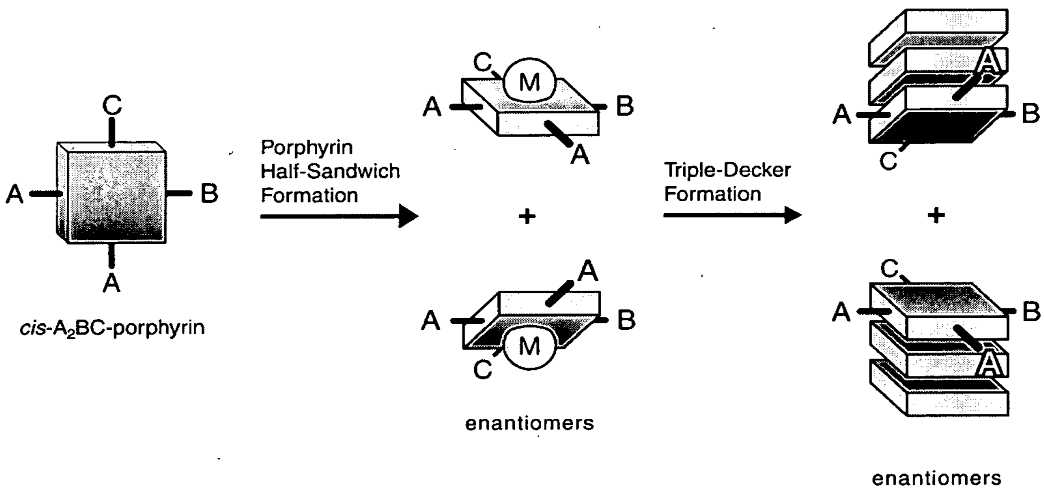

C
A
B
A
cis-A2BC-porphyrin
Porphyrin
Half-Sandwich
Formation
M
enantiomers
Triple-Decker
Formation
enantiomers

Fig. 14

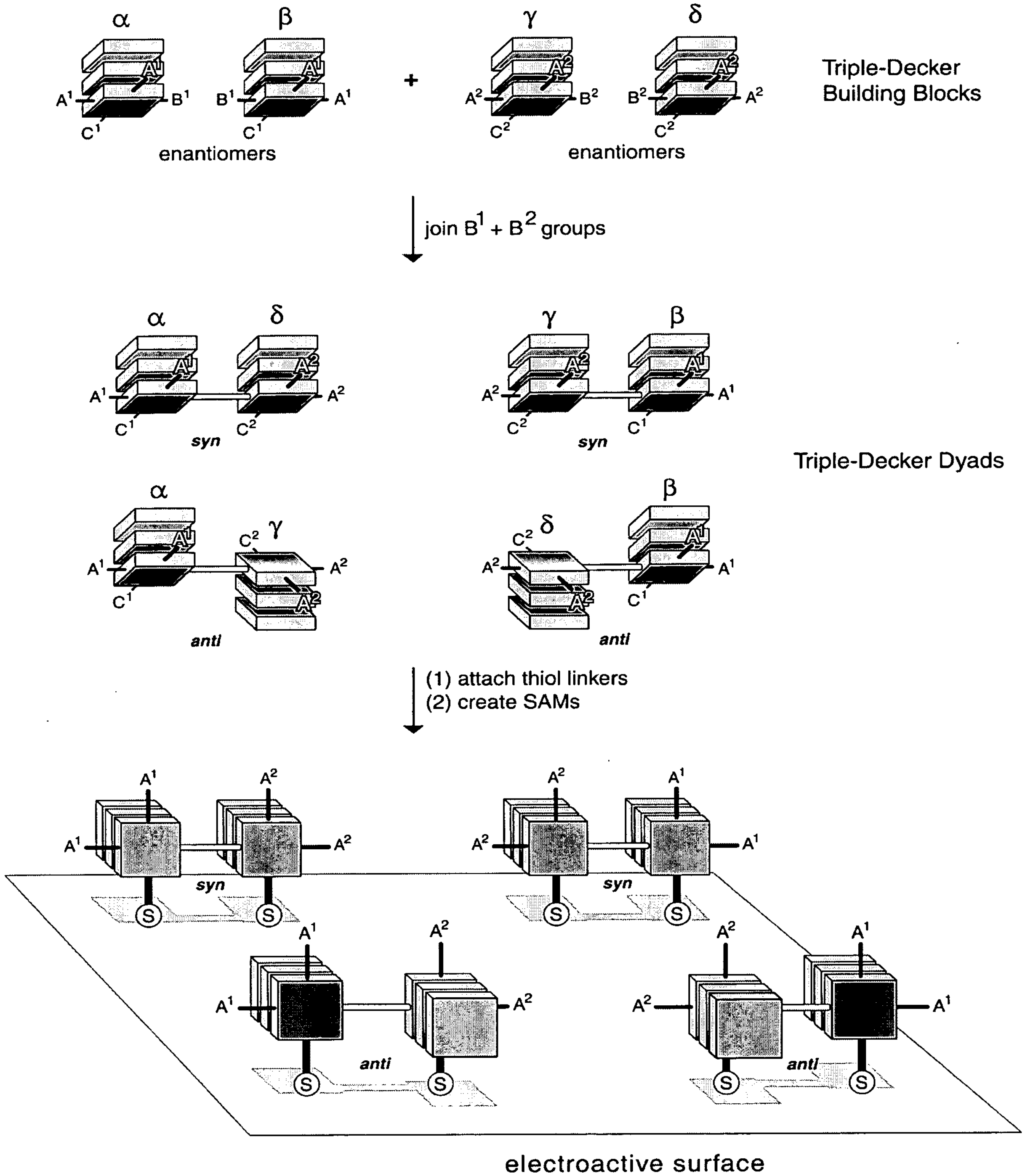

α
β
γ
δ
Triple-Decker Building Blocks
enantiomers
enantiomers
join B1 + B2 groups
syn
syn
anti
anti
Triple-Decker Dyads
(1) attach thiol linkers
(2) create SAMs
syn
syn
anti
anti
electroactive surface

Fig. 15

Scheme 1

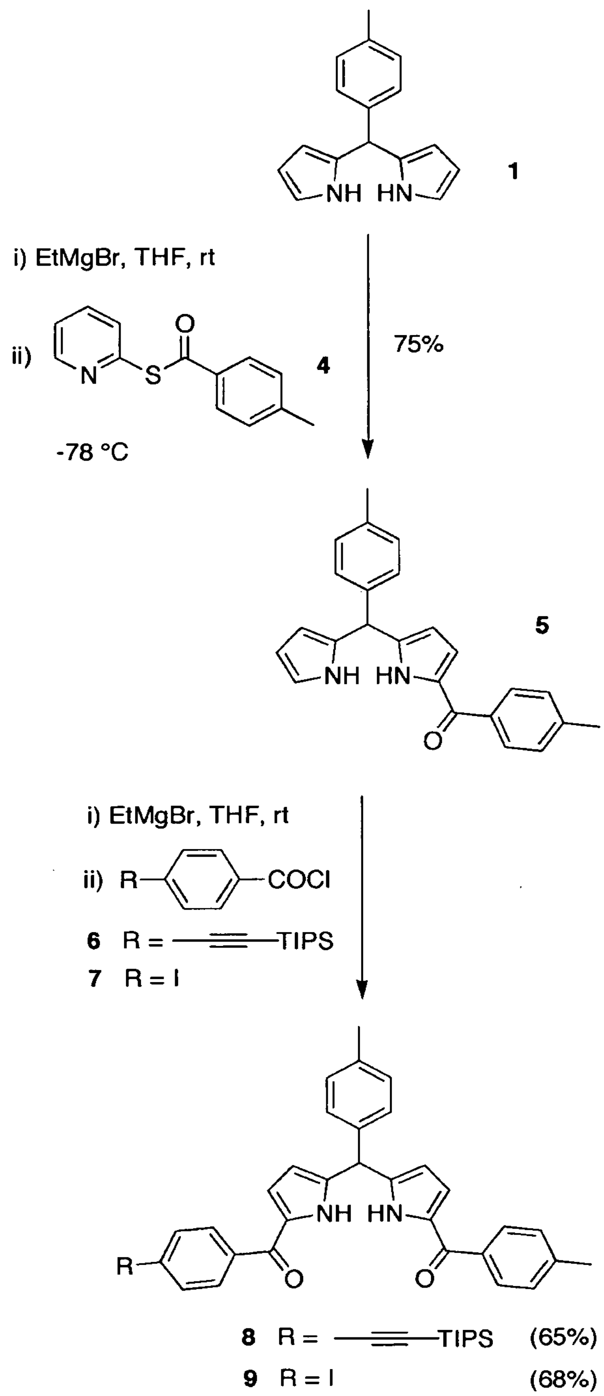
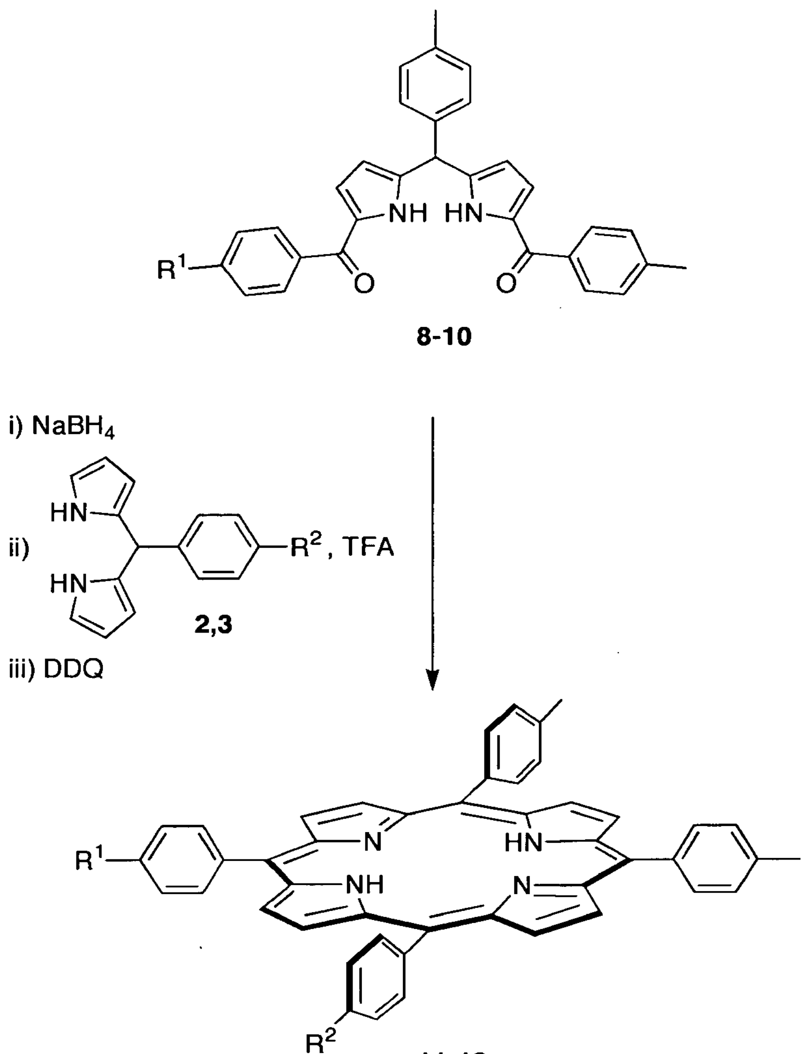


Fig. 16

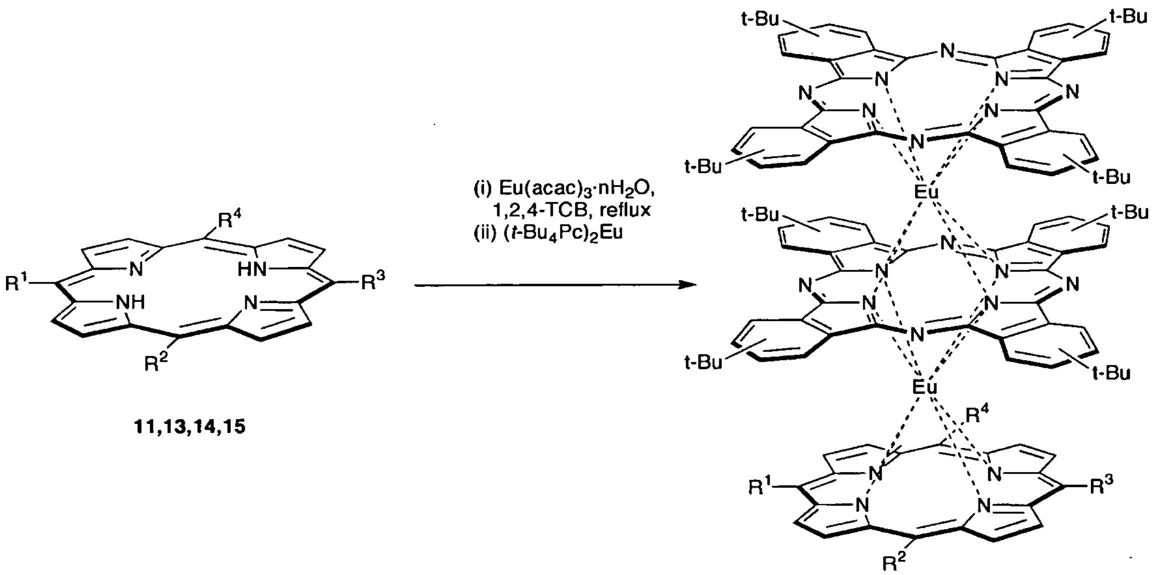
Scheme 2



Precursors	R^1	R^2	Porphyrin
8 + 2	—≡—TIPS	—≡—TMS	**11** (20%)
9 + 2	I	—≡—TMS	**12** (21%)
10 + 3	CH_3	I	**13** (21%)

Fig. 17

Scheme 3



TD7-10

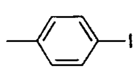
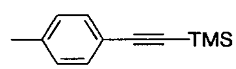
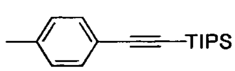
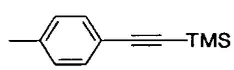
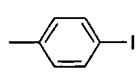
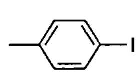
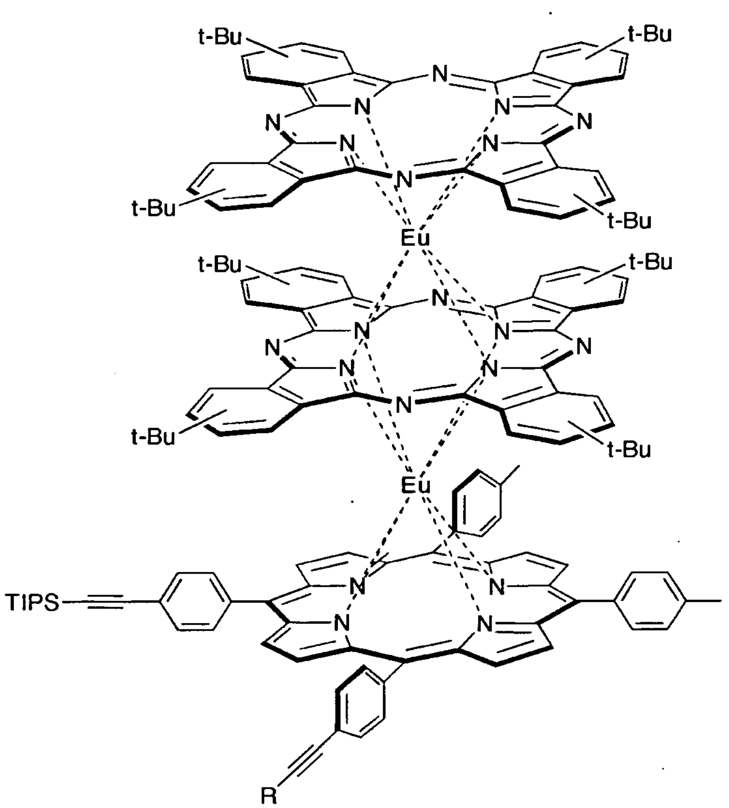
Porphyrin	R^1	R^2	R^3	R^4	Triple Decker	Yield
14		*p*-tolyl		*p*-tolyl	**TD7**	74%
11	*p*-tolyl			*p*-tolyl	**TD8**	79%
13	*p*-tolyl	*p*-tolyl		*p*-tolyl	**TD9**	62%
15	*n*-pentyl	*n*-pentyl		*n*-pentyl	**TD10**	25%

Fig. 18

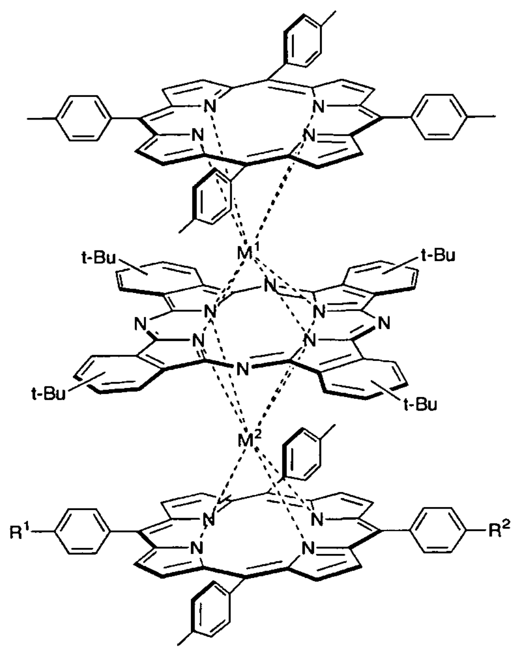


TD8 R = TMS → **TD8'** R = H

K_2CO_3, $CHCl_3$/THF/MeOH, rt
90%

Fig. 19

Chart 1

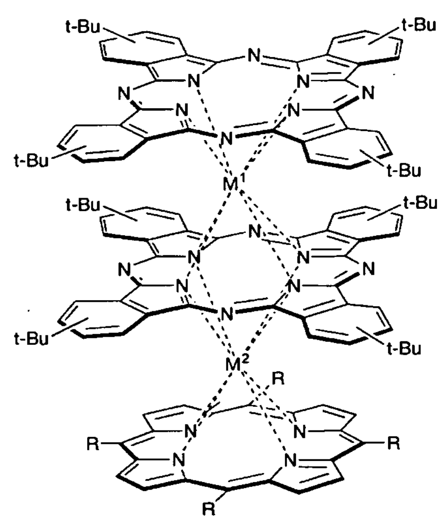


Type a triple deckers

TD1 M^1/M^2 = Eu, R^1/R^2 = CH_3

TD2 M^1/M^2 = Ce, R^1/R^2 = CH_3

TD3 M^1 = Eu, M^2 = Ce, R^1 = I, R^2 = —≡—TMS



Type c triple deckers

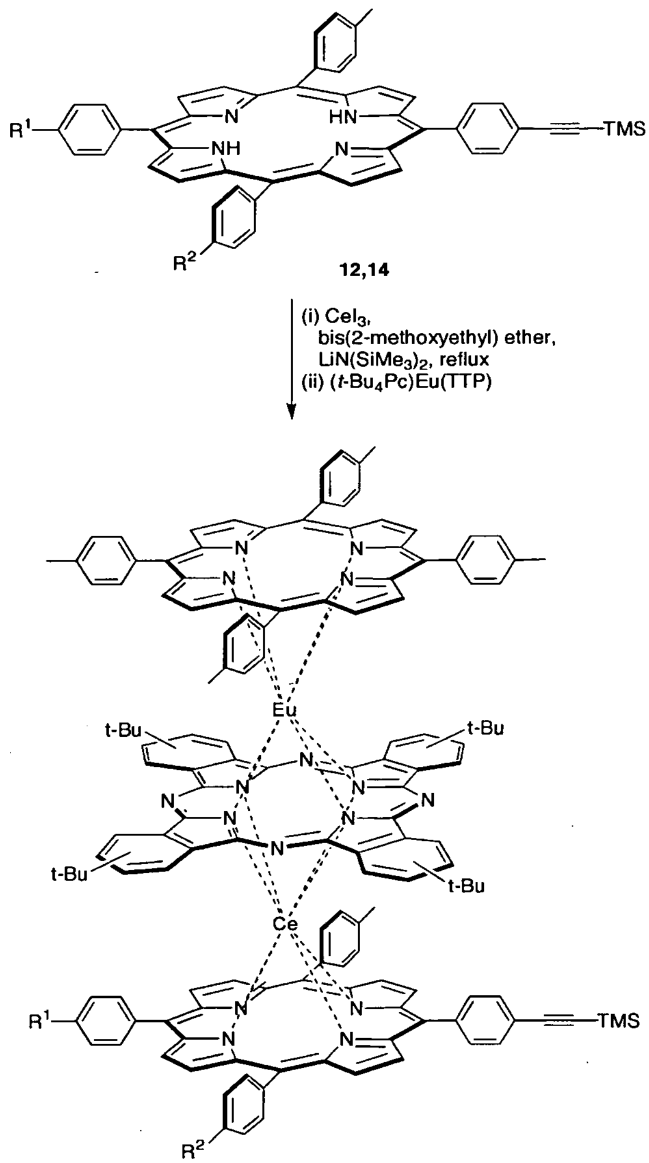
TD4 M^1/M^2 = Eu, R = *p*-tolyl

TD5 M^1 = Eu, M^2 = Ce, R = *p*-tolyl

TD6 M^1/M^2 = Eu, R = *n*-pentyl

Fig. 20

Scheme 5



TD3,11

Porphyrin	R^1	R^2	Triple Decker	Yield
12	CH_3	I	**TD11**	54%
14	I	CH_3	**TD3**	46%

Fig. 21

Scheme 6

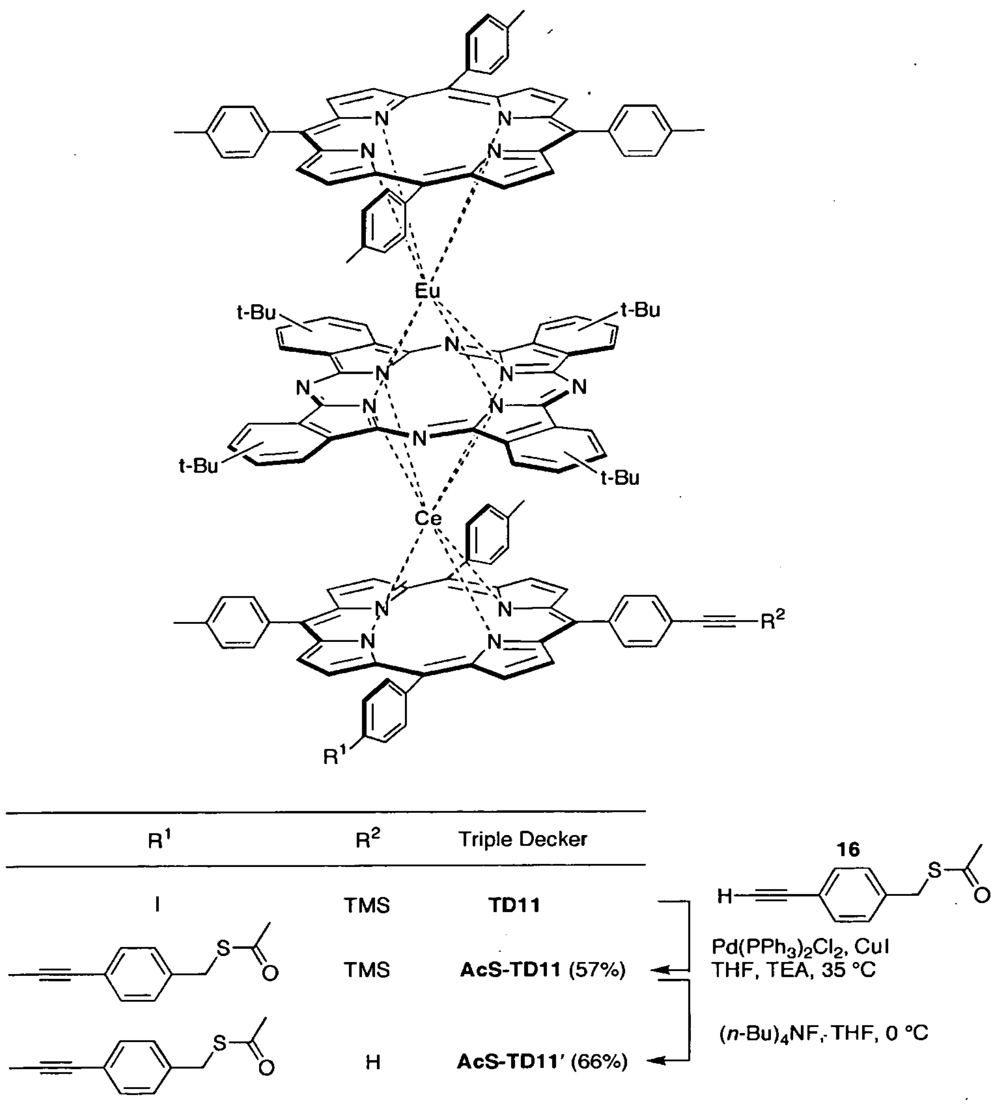


Fig. 22

Scheme 7

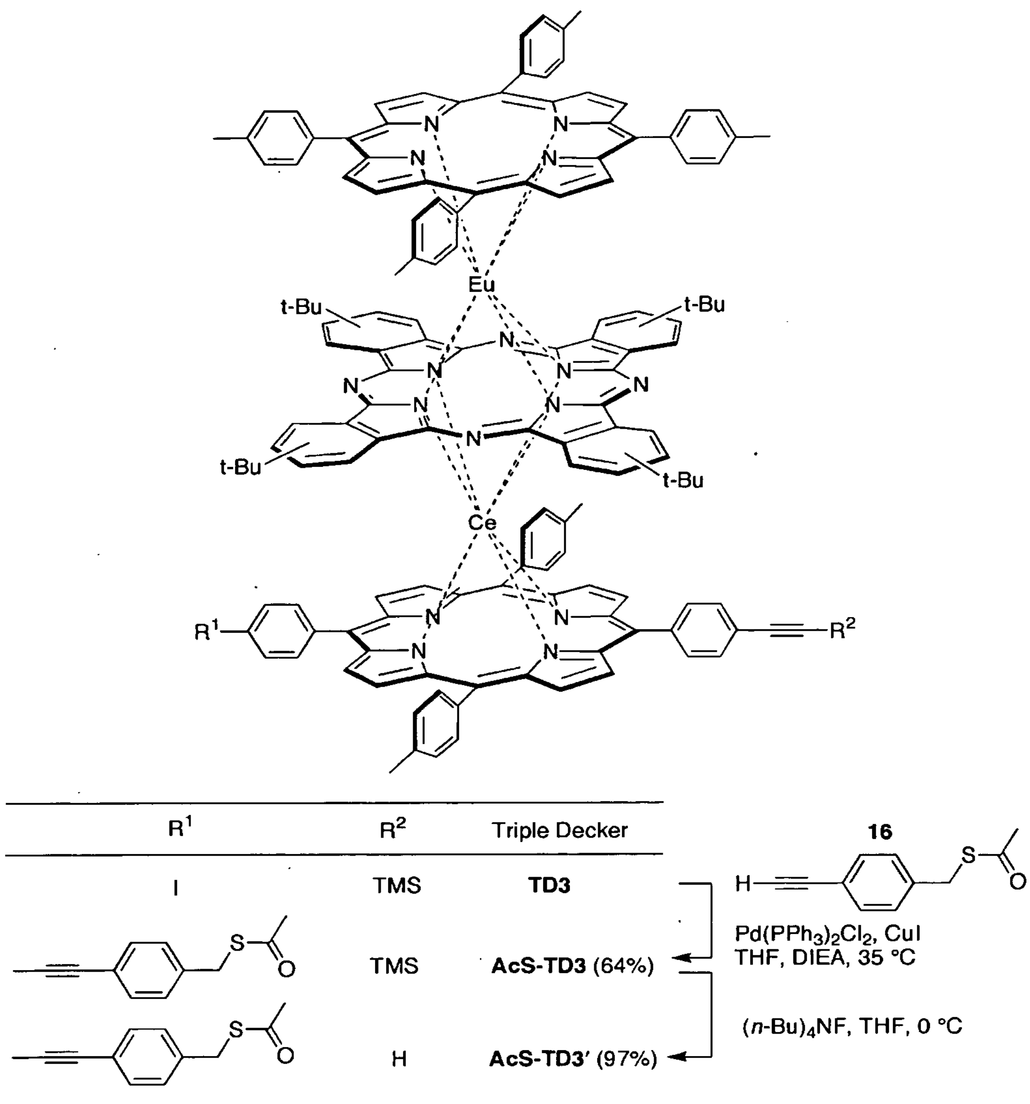


Fig. 23

Scheme 8

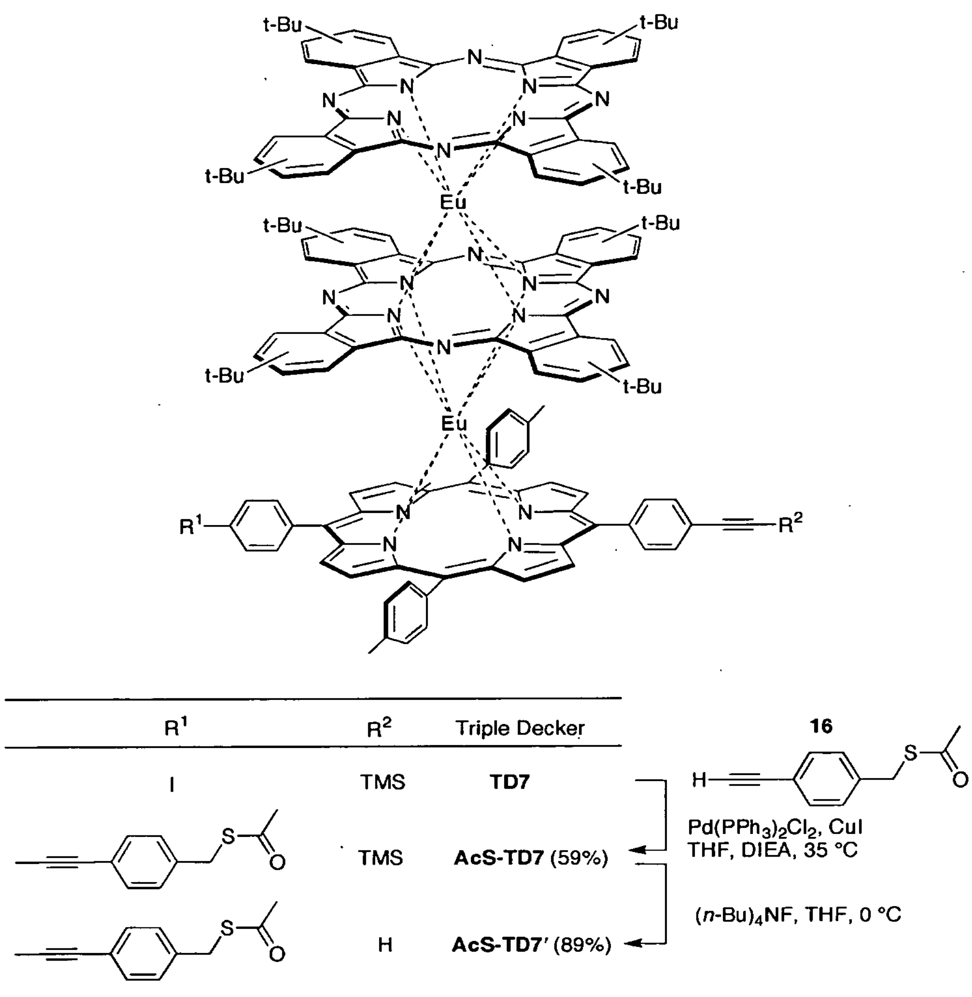
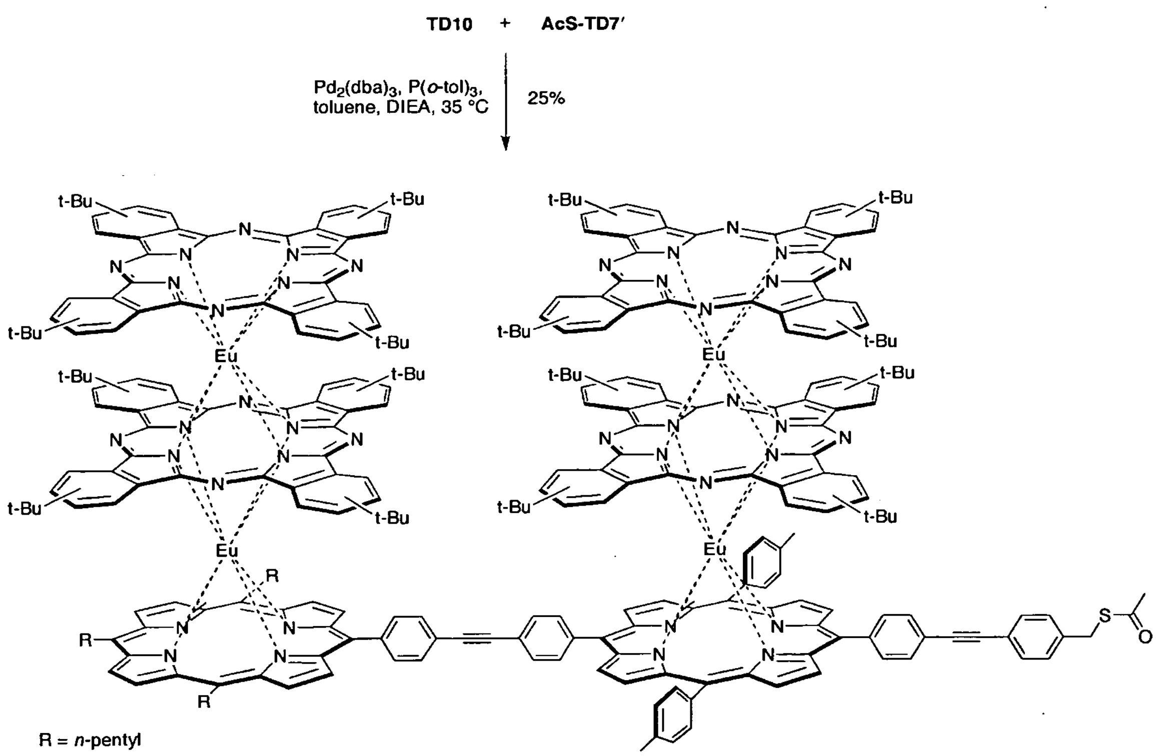


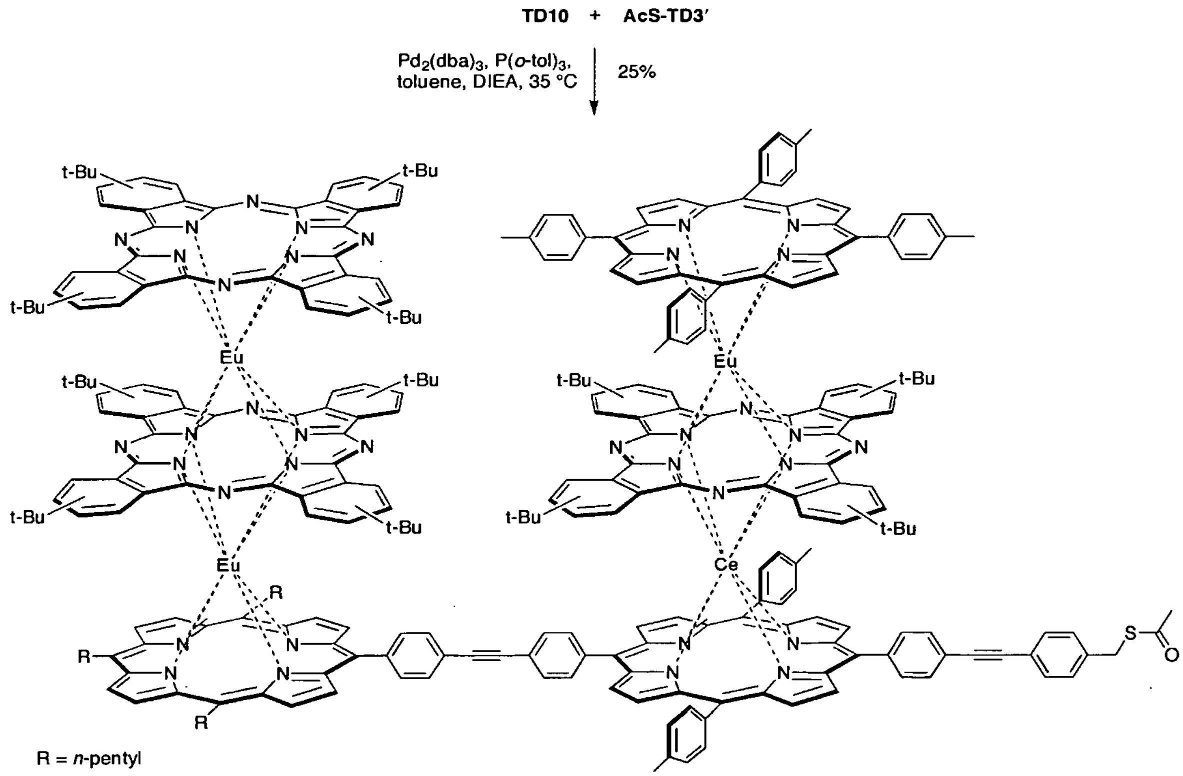
Fig. 24

Scheme 9



Dyad1

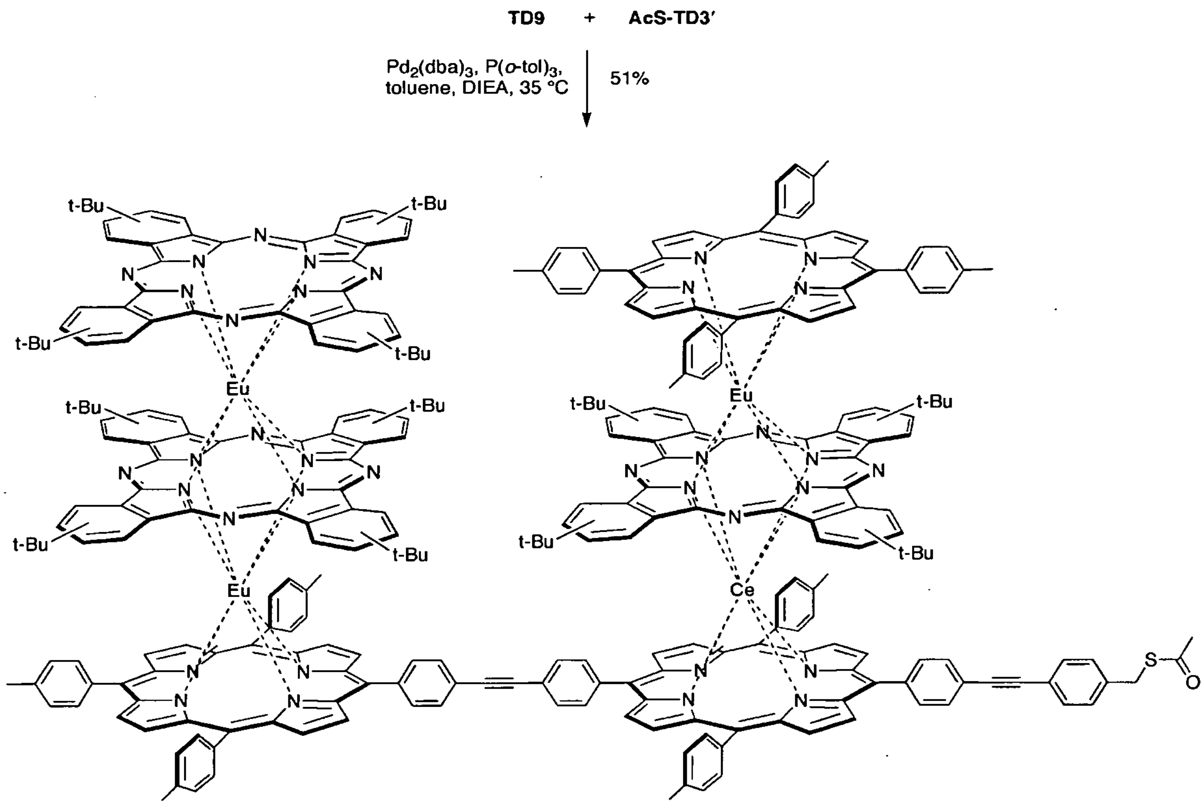
Fig. 25


TD10 + AcS-TD3′
$Pd_2(dba)_3$, $P(o\text{-tol})_3$,
toluene, DIEA, 35 °C
25%
t-Bu
N
Eu
Ce
R
S
O
R = n-pentyl

Dyad2

Fig. 26

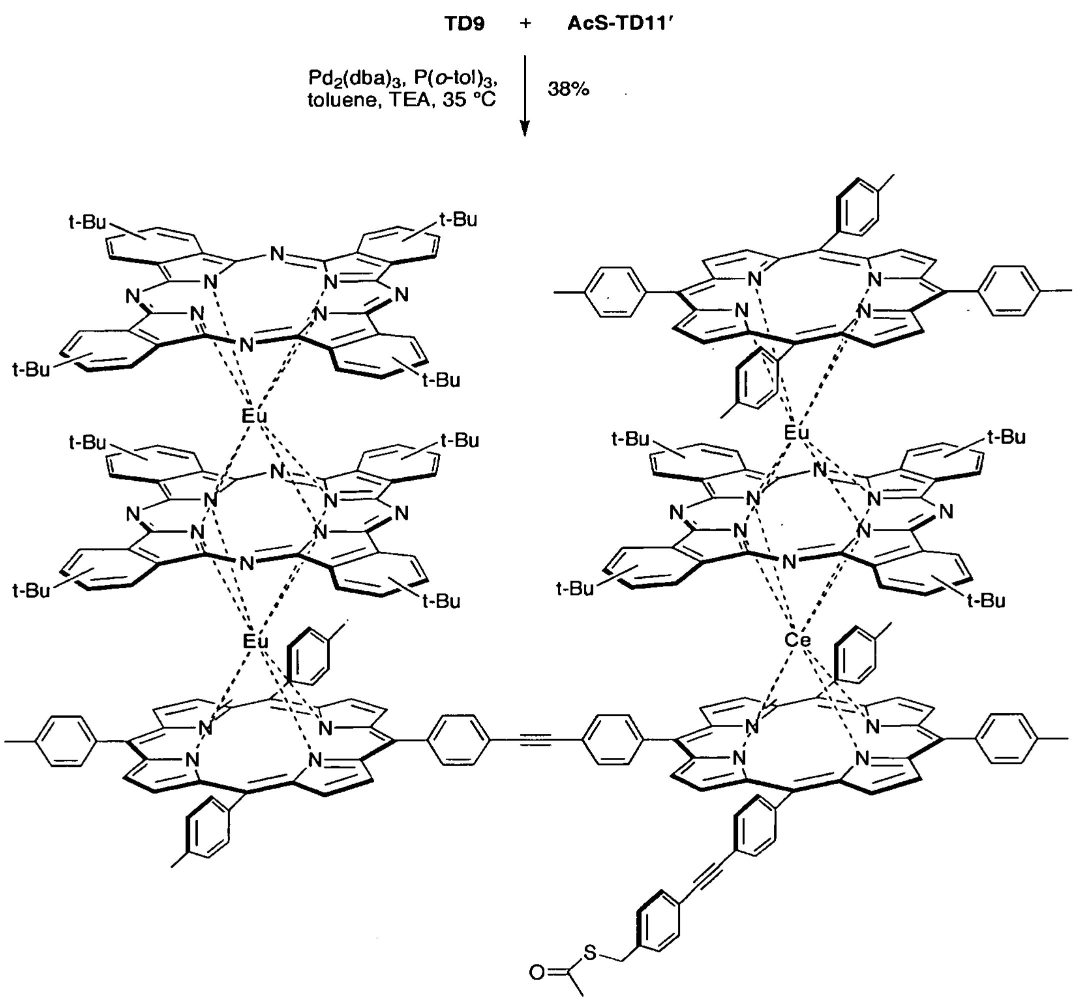
Scheme 11



Dyad3

Fig. 27

Scheme 12



Dyad4

Fig. 28

Scheme 13

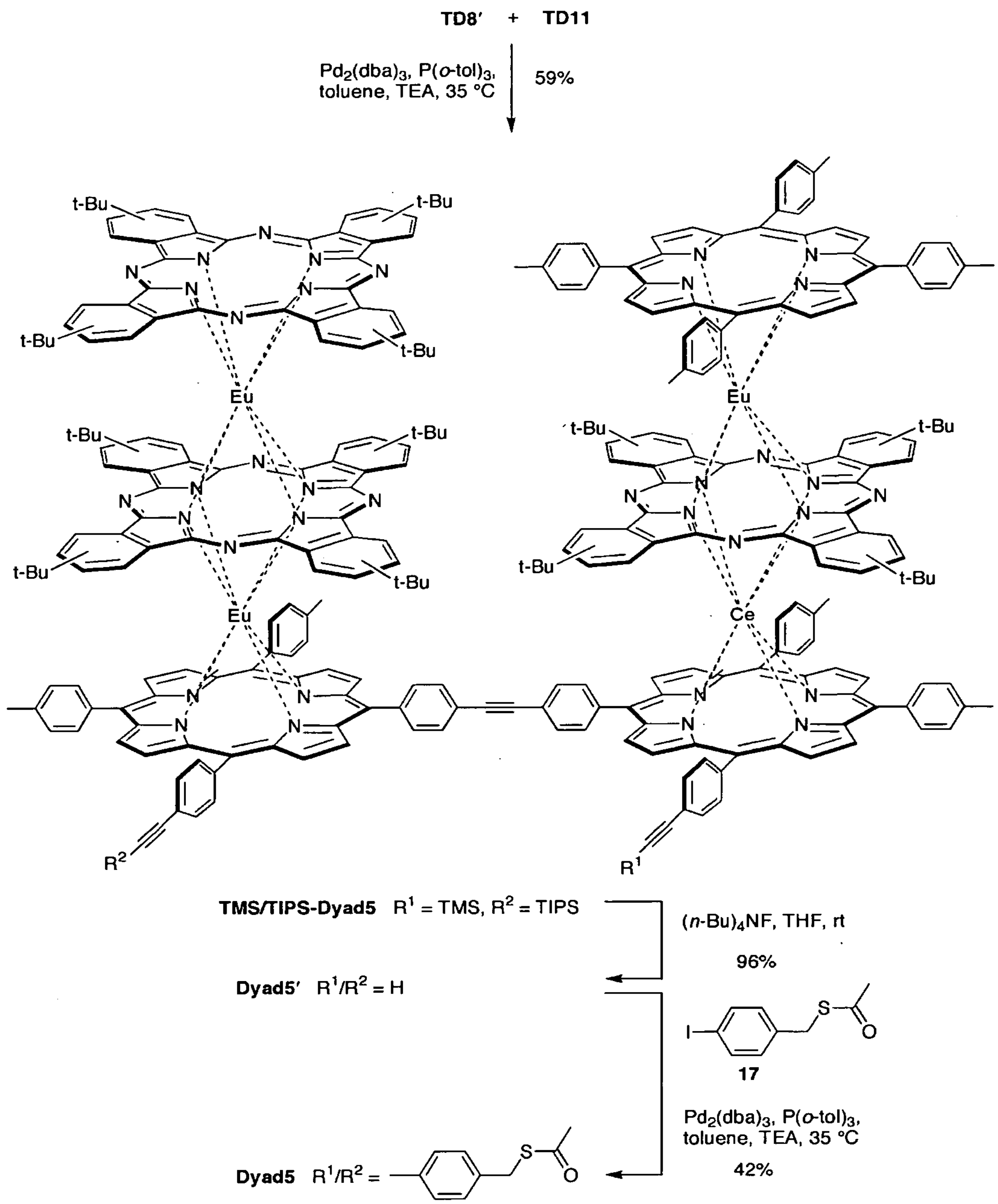
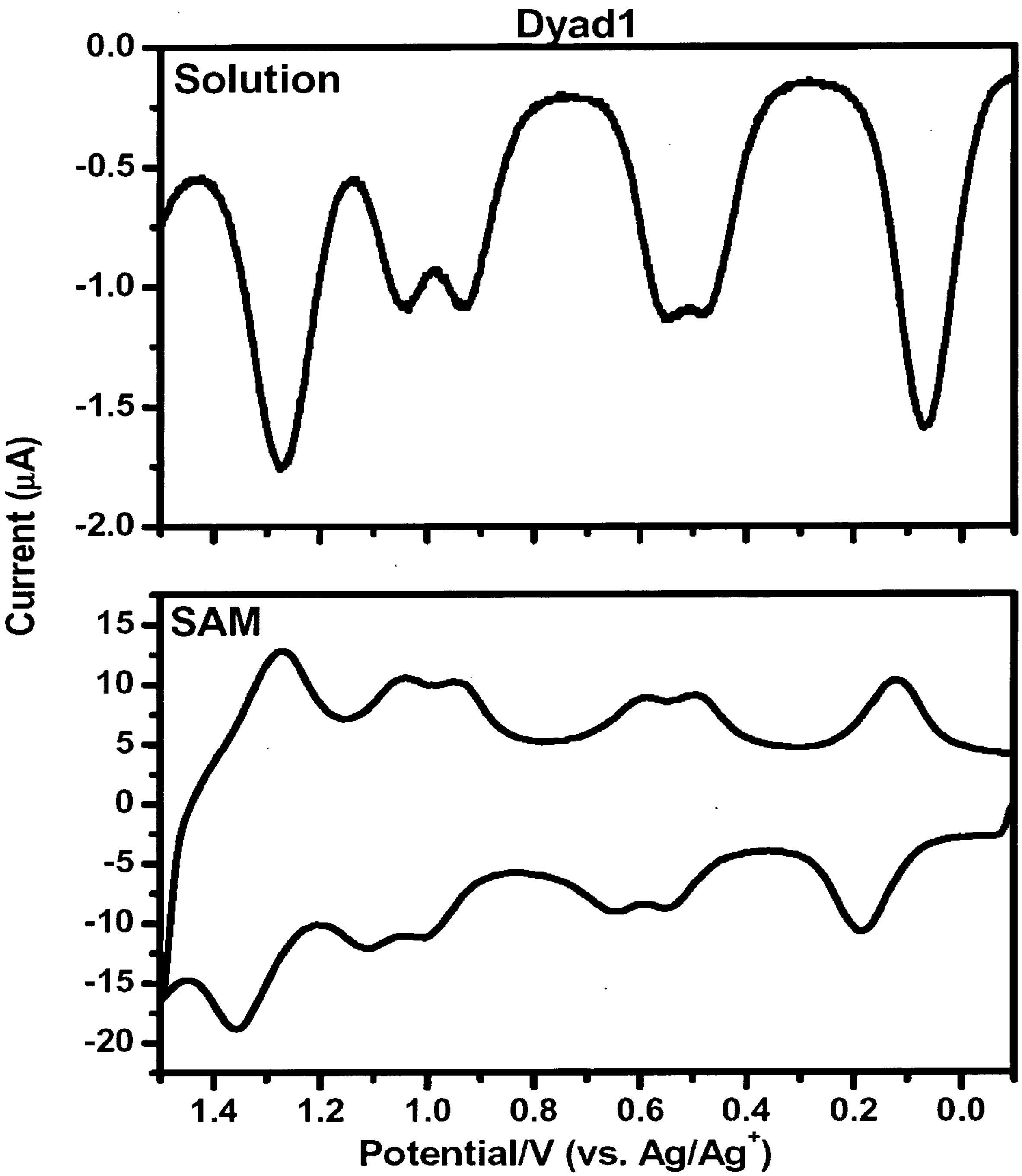


Fig. 29



Dyad1
Solution
0.0
-0.5
-1.0
-1.5
-2.0
Current (μA)
SAM
15
10
5
0
-5
-10
-15
-20
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Potential/V (vs. Ag/Ag+)

Fig. 30

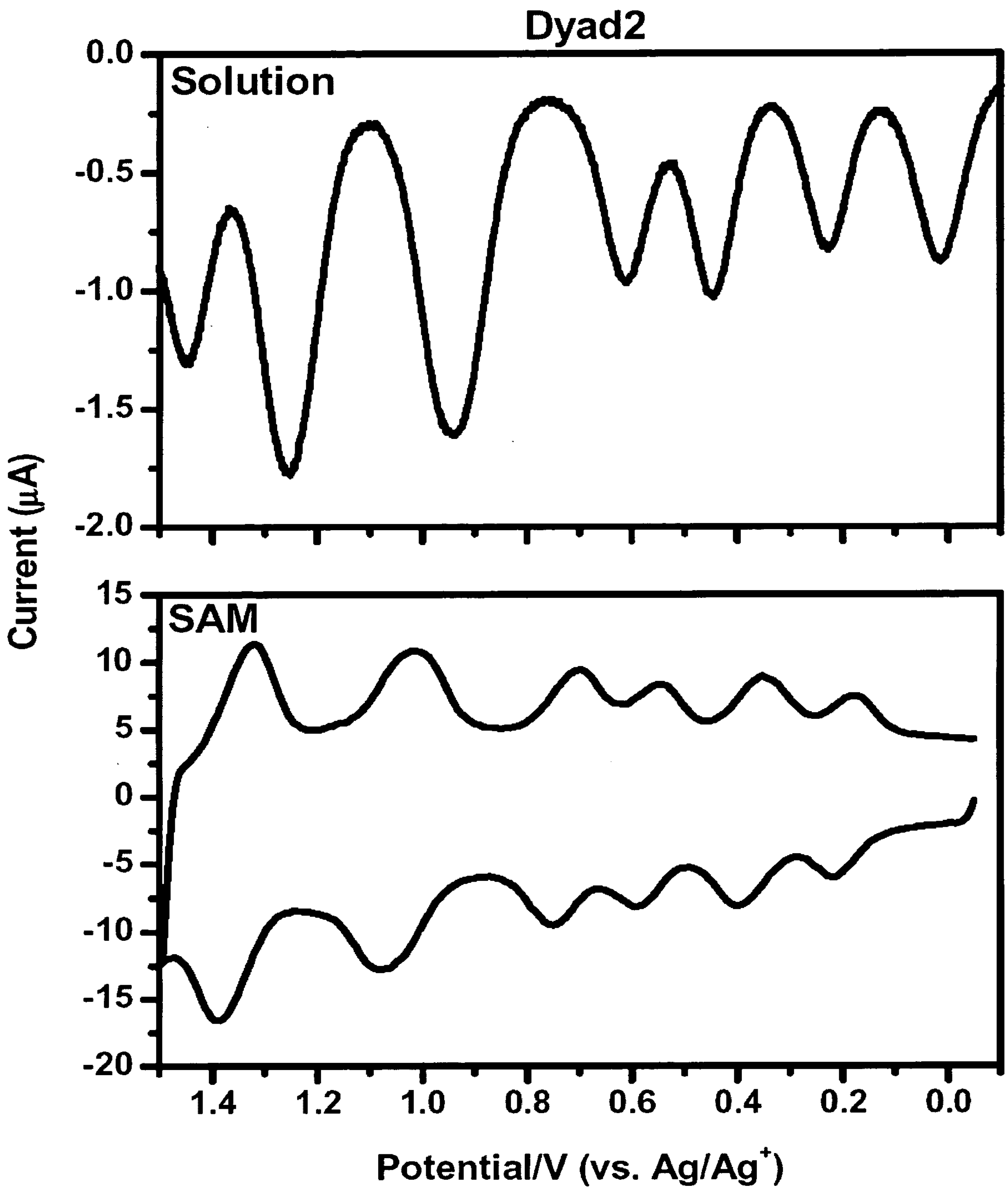

Dyad2
Solution
SAM
Current (μA)
Potential/V (vs. Ag/Ag⁺)
0.0
-0.5
-1.0
-1.5
-2.0
15
10
5
0
-5
-10
-15
-20
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0

Fig. 31

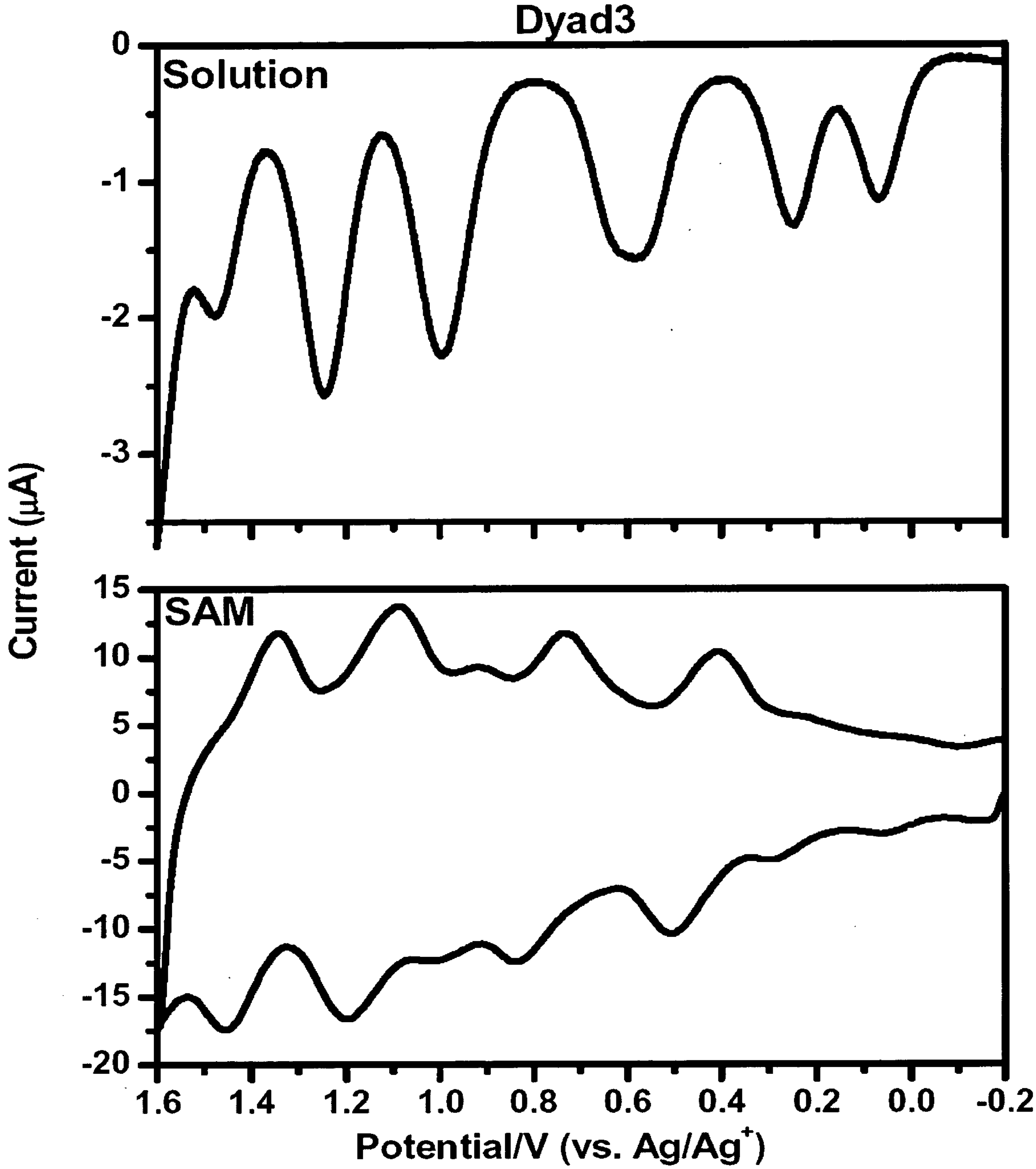
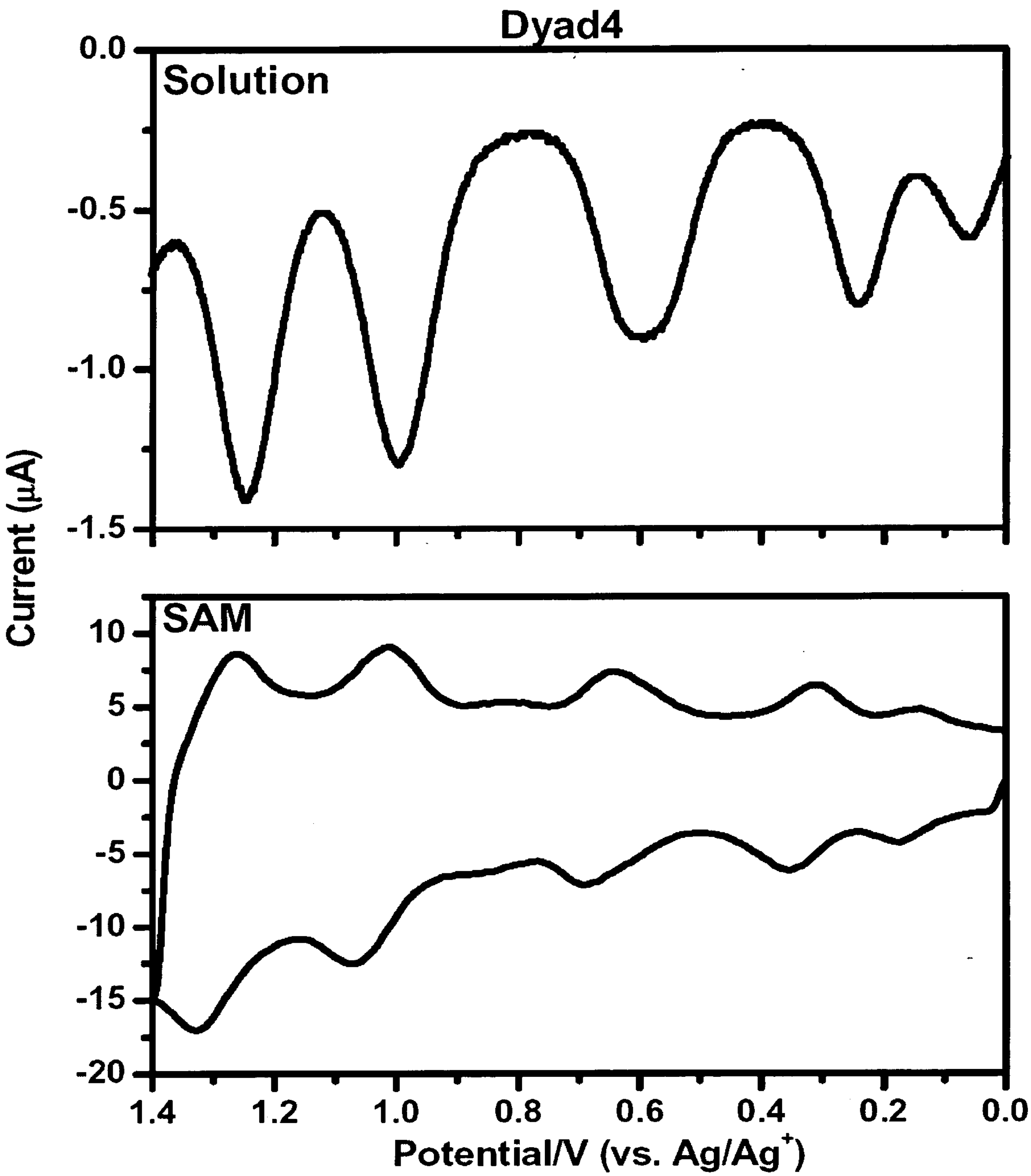

Dyad3
Solution
SAM
Current (μA)
0
-1
-2
-3
15
10
5
0
-5
-10
-15
-20
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
Potential/V (vs. Ag/Ag+)

Fig. 32



Dyad4
Solution
SAM
Current (μA)
0.0
-0.5
-1.0
-1.5
10
5
0
-5
-10
-15
-20
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Potential/V (vs. Ag/Ag+)

Fig. 33

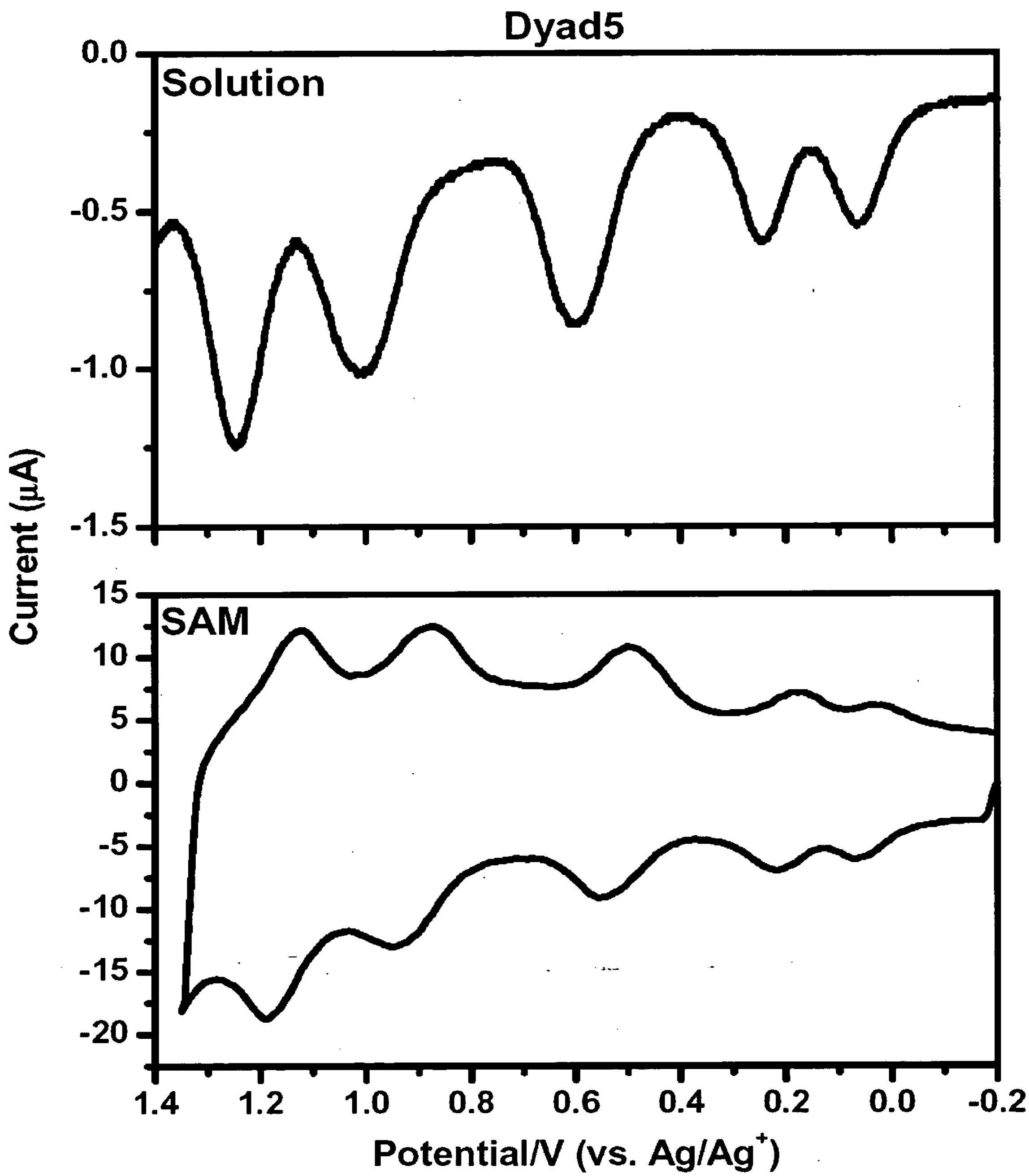

Dyad5
Solution
SAM
Current (μA)
0.0
-0.5
-1.0
-1.5
15
10
5
0
-5
-10
-15
-20
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
Potential/V (vs. Ag/Ag+)

Fig. 34